(2)

ESL-TR-81-44

P - 13 DUAL AGENT APPLICATION

MR. LYLE McDONALD
JOHN HAMRE, MSGT, USAF

ANSUL COMPANY
MARINETTE, WISCONSIN

AUGUST 1981

FINAL REPORT
AUGUST 1979 - AUGUST 1981

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

AIR FORCE ENGINEERING AND SERVICES CENTER

AFESC

ENGINEERING AND SERVICES LABORATORY
AIR FORCE ENGINEERING AND SERVICES CENTER
TYNDALL AIR FORCE BASE, FLORIDA 32403

Best
Available
Copy

NOTICE

PLEASE DO NOT REQUEST COPIES OF THIS REPORT FROM HQ AFESC/RD (ENGINEERING AND SERVICES LABORATORY). ADDITONAL COPIES MAY BE PURCHASED FROM:

NATIONAL TECHNICAL INFORMATION SERVICE
5285 PORT ROYAL ROAD
SPRINGFIELD, VIRGINIA 22161

FEDERAL GOVERNMENT AGENCIES AND THEIR CONTRACTORS REGISTERED WITH DEFENSE TECHNICAL INFORMATION CENTER SHOULD DIRECT REQUESTS FOR COPIES OF THIS REPORT TO:

DEFENSE TECHNICAL INFORMATION CENTER
CAMERON STATION
ALEXANDRIA, VIRGINIA 22314

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER ESL-TR-81-44	2. GOVT ACCESSION NO. AD-A112490	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) P-13 Dual Agent Application		5. TYPE OF REPORT & PERIOD COVERED Final Report August 1979-August 1981
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Mr. Lyle McDonald John Hamre, MSgt, USAF		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS ANSUL Company Marinette, Wisconsin		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS JON: 2505-1002 Program Element 64708F
11. CONTROLLING OFFICE NAME AND ADDRESS HQ AFESC/RDCS Tyndall AFB FL 32403		12. REPORT DATE Aug 81
		13. NUMBER OF PAGES 44
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Availability of this report is specified on reverse of front cover.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Twin Agent
Skid Mounted
Dual Nozzle
Twin Line

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The two seperate hose reel assemblies on the AS 32/P-13 were replaced with a single electric rewind reel containing 100 feet of twinned one inch hose. Agent discharge piping was rerouted to opposite sides of the hose reel and the agents are discharged through a dual agent nozzle assembly capable of being operated easily by one man.
The existing two ball valve type nozzles are replaced with a single dual agent nozzle configuration capable of discharging dry chemical and Halon 1211. A standard electric rewind twinned hose reel was installed with attention to wiring

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

20. ABSTRACT (CONTINUED)

harness routes, power requirements and operation. The electrical requirements are within the present capability of the vehicle, and harness routing follows current vehicle specifications to prevent chaffing, weathering and other damage. The operating controls have been located to allow one man to energize the rewind mechanism and also guide the hose onto the reel.

The actuation systems of both units are combined to facilitate a one-person operation (movement of one lever opens all valves). This actuation lever is located at the rear of the vehicle in the vicinity of the dual agent nozzle. A provision was incorporated into the system to clear agents from the hose after use.

The dispensing system satisfies the flight and taxiing load requirements of MIL-A-8421.

The modified components of the vehicle can be discharged independently and simultaneously from their respective nozzles to insure satisfactory operation and conformance to the flow requirements.

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

PREFACE

This final report was prepared by the Ansul Company, Marinette Wisconsin, under Contract F08635-80-C-0232 with the Air Force Engineering and Services Center, Tyndall Air Force Base, Florida. Job Order Number 2505-1002.

This report has been reviewed by the Public Affairs (PA) office and is releaseable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

Joseph L. Walker

JOSEPH L. WALKER
Project Officer

John E. Goin

JOHN E. GOIN, LtCol, USAF
Chief, Engineering Research Division

Francis B. Crowley III

FRANCIS B. CROWLEY, III, Col, USAF
Director Engineering and Services Laboratory

Accession For	
NTIS GRA&I	☑
DTIC TAB	☐
Unannounced	☐
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A	

DTIC COPY

(The reverse of this page is blank)

TABLE OF CONTENTS

LIST OF FIGURES

SECTION I

INTRODUCTION

1. OBJECTIVE

The objective of this effort was to develop a dual fire suppression agent dispensing system for the AS 32/P-13 airfield ramp firefighting vehicle. That could dispense both dry chemical agent (PKP) and liquid vaporizing agent (Halon 1211) either singly or simultaneously from one nozzle. This dispensing system was also to satisfy the flight and taxiing load requirements of MIL-A-8421 and to be capable of being operated by one fire fighter.

2. BACKGROUND

The AS 32/P-13 vehicle was designed as a fast response vehicle for use as a standby and airfield ramp patrol vehicle to relieve some of the required duties of the primary aircraft crash rescue vehicles. The two auxiliary agents carried on the vehicle, Halon 1211 and dry chemical (PKP) have been shown to give the vehicle an advantage in fighting aircraft fires.

Halon 1211 (Bromochlorodifluormethane) is a "clean" agent capable of being used as a wet fire suppression agent without damage to aircraft components from chemical reactions and corrosion. PKP (potassium bicarbonate) is considered an excellent flame "knockdown" agent for class B fuel fires. This agent is utilized for all types of aircraft and ground fires not requiring a "clean" agent.

The AS 32/P-13 was designed to be operated by a two-person fire fighting crew. Increased costs and limited manpower make it an economically feasible alternative to change the present configuration to that of a twin-line, dual nozzel type dispensing unit which retains its proficiency, while being operated by one fire fighter.

3. APPROACH

The actuation system of the presently separate dispensing units were combined so that movement of one lever would open all valves and enable one person to operate a dual agent nozzle. The two separate hose assemblies were replaced by a single hose with a dual agent nozzle. A provision to clear agents from the hoses after use was also incorporated.

Modified components capable of being discharged independently and simultaneously from their respective nozzles were tested and evaluated to ensure satisfactory operation and conformance to flow requirements.

SECTION II

DISCUSSION

1. MODIFICATIONS

The AS 32/P-13 fire fighting vehicle previously designed for operation by two fire fighters has been converted to a one-person operation. The modified system can be either actuated manually as a separate unit or pneumatically for a dual system. The two separate hose assemblies were replaced with a single electric rewind reel containing 100 feet of twin agent hose with a single dual agent nozzle. The parts needed for this modification are listed in Appendix B.

The wiring harness routes from the electric rewind reel to the source of power are enclosed in a weather tight flexible conduit to prevent any weathering or chaffing to the wiring harness and can be disconnected at a weather tight box located on skid the unit.

The skid mounted system can be removed from the truck bed by disconnecting electrical wiring at the weather tight box and removing six bolts that fasten the skid to the truck bed. The skid unit is balanced so it can be lifted at the dry chemical tank eye hooks.

2. TESTING

Flow testing was done with 100 feet of twin agent 1-inch hose and dual agent nozzle assembly. The flow requirements for Halon 1211 were 5.0 to 5.5 pounds per second and an effective range of 40 feet. Discharge of the Halon unit was recorded on the Dynagraph. At 2/3 of 95 percent discharge time, the flow rate was 5.4 pounds per second. Prints of the nozzle assembly are attached. Flow rate on Purple-K agent was also recorded on the Dynagraph and the flow requirements were 6.5 to 8.0 lbs per second, using a converging/diverging nozzle. At the 2/3 of 95 percent discharge time, the flow rate of 7.5 pounds per second was recorded.

A problem that arose during the test program was sand in the Halon tank from previous sandblasting. During filling and discharge, sand would accumulate into the tank check valve, tank hose clean out valve, and tank outlet valve. All mentioned valves had to be replaced with new valves. The Halon tank was removed so the sand could be vacuumed out and piping to the valves was also cleaned. The sandblasting sand removal, eliminated the problem of scoring valve seats for leakage problems.

The tank hose clean-out valve and tank outlet valve were tested (N_2 at 200 psi and leak checked with soap solution) prior to installation, with no visible leaks. Ball valves were installed on the unit in a closed position and the Halon tank was pressurized to 200 psi and let stand overnight. There was some pressure in the line to the nozzle.

Valves were then pressurized to 950 psi to square up the seat for more positive seal between the ball and the seat and then tested with a soap solution. There were no visible leaks. Valves were again pressurized to 200 psi and let stand with a soap solution. Again, there were no visible leaks. Valves were installed as per print 55660 with the threaded spacers as the inlet parts of the valve. The halon tank was pressurized with N_2 to 250 psi and left to stand with the hose clean out valve closed (normally closed) and tank outlet valve closed (normally closed). Again, there was some pressure to the nozzle. The Halon tank was then charged with 50 pounds of Halon 1211 to leak test valves with vapor pressure. All during the testing, the hose line was never purged with air so there probably was an accumulation of vapors in the nozzle.

Two new valves were sent from the Marpac Company with new seating material KEL-F and RTFE. The new material has a lower coefficient of expansion than the standard TFE material. Three Marpac valves with the three seating materials were installed on 2-1/2 pound shells charged with approximately 1 pound of Halon 1211 and pressurized to 240 psi. Units were leak tested at Systems Halon filling station with the Halogen leak detector. Results are:

a. Standard valve P/N 54286 TFE seats leak rate .05 oz/yr no leakage.

b. RTFE seats leak rate .05 oz/yr no leakage.

c. KEL-F seats leak rate 0.05 oz/yr no leakage.

The Halon was dumped from the shells, recharged with 1211 and left unpressurized to simulate the P-13 unit. This method determined the amount of vapor lost per year.

a. Results are TFE seats .25 oz/yr no leak.

b. RTFE seats .05 oz/yr moderate.

c. KEL-F seats .05/oz yr moderate.

Standard valve with TFE seats pressurized to 950 psi to square up the seat as per unit 36238 and then installed on 2-1/2 shell with 1211 and unpressurized, leak rate .05 oz/yr.

Aqueous film forming foam (AFFF) nozzle assembly P/N 54742 was converted for Halon 1211 had to have compression spring P/N

25786 changed to a heavier compression due to back pressure in the nozzle. The nozzle would not shut off. Standard compression spring P/N 25786 specifications are free length 1.350 inches to 1380 inches, active coils 6, wire diameter .080 inches, compression 26.6 pounds at 1.0 inches. Replacement spring free length 1.300 inches, active coils 6, wire diameter .092 inches, compression 70 pounds at 7/16 inches.

3. EVALUATION

After modifications and testing, the following evaluations were made:

a. The nozzle with a new spring was tested on a 350 wheeled unit charged with water and cycled to determine shut off performance. The spring is capable of shutting off the nozzle with water or Halon.

b. The nozzle has been tested for both shutoff and sealing capabilities and has performed satisfactorily.

c. Manual and pneumatic actuation of the dual system is operationally satisfactory.

d. The operational discharge range of the dual agent nozzle is satisfactory.

SECTION III

CONCLUSIONS

The modification of the AS 32/P-13 fire fighting vehicle from a two-person configuration to one that could be operated by one person with no loss of proficiency was successful; see Appendix A. The unit was converted to a single electric rewind reel containing 100 feet of twin agent hose with a dual nozzle and an actuation system that can be operated manually or pneumatically.

Flow testing and effective range testing met the USAF requirements for Halon 1211 and PKP Dry Chemical agents.

The modified dispensing system satisfied the flight and taxiing load requirements of MIL-A-8421. All hose reel/hose reel base attachments to the mounting base were acceptable according to the procedures defined.

APPENDIX A

AIR TRANSPORTABILITY EQUATIONS

NOTE: Air transportability Equations are identical to those for the previous P-13 truck design, with the exception of the [illegible] calculations. These calculations have been redone and are presented here.

HOSE REEL ASSEMBLY - SUB SECTION A

1. <u>Calculation Set A - Fore and Aft</u> (Figure 1)

These calculations will consider a force (F) equal to 3 g applied perpendicular and horizontal to the hose reel axis. Force can be fore or aft since stress loads (F_s) will be equal in either direction.

Weight of hose reel and components = 324#

The bearings are designed to withstand a radial load of 2,940 pounds. Therefore, the bearings are acceptable in the fore and aft direction since a force (T_t) of 480 pounds is applied to both bearings. Note that each bearing will share the total load equally.

All friction forces will be ignored as will the weight of the reel since this will provide for maximum stress loads.

a. <u>Shear Load on Bolts (Figure 2)</u>

Bolts are 3/8 - 16

$Fy = 0$ $\qquad$ F_{S_L} = Shear on left bolt

$F_{S_L} + F_{S_R} - 3\ (162) = 0$ $\qquad$ F_{S_R} = Shear on right bolt

$2\ F_S = 3\ (162)$ $\qquad$ $F_{S_L} = F_{S_R} = F_S$

<u>FS = 243 pounds</u>

$$\sigma = \frac{243}{A}$$

$$\sigma = \frac{243}{A} = \frac{4\ (243)}{.2983}$$

σ = Shear stress
A = Area

$$\sigma = \underline{3477 \text{ psi}}$$

Shear stress is well below the yield shear stress of approximately 15,000 psi.

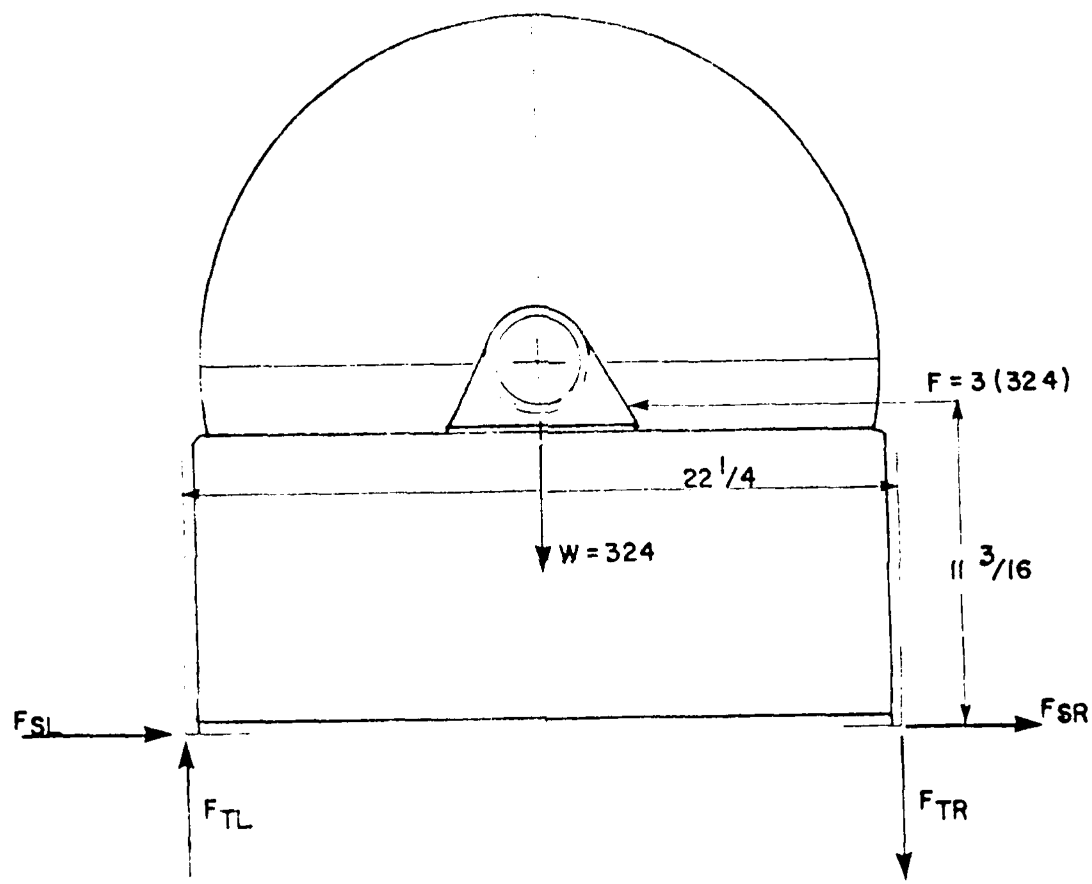

Figure-1 Calculation Set A-Fore and Aft

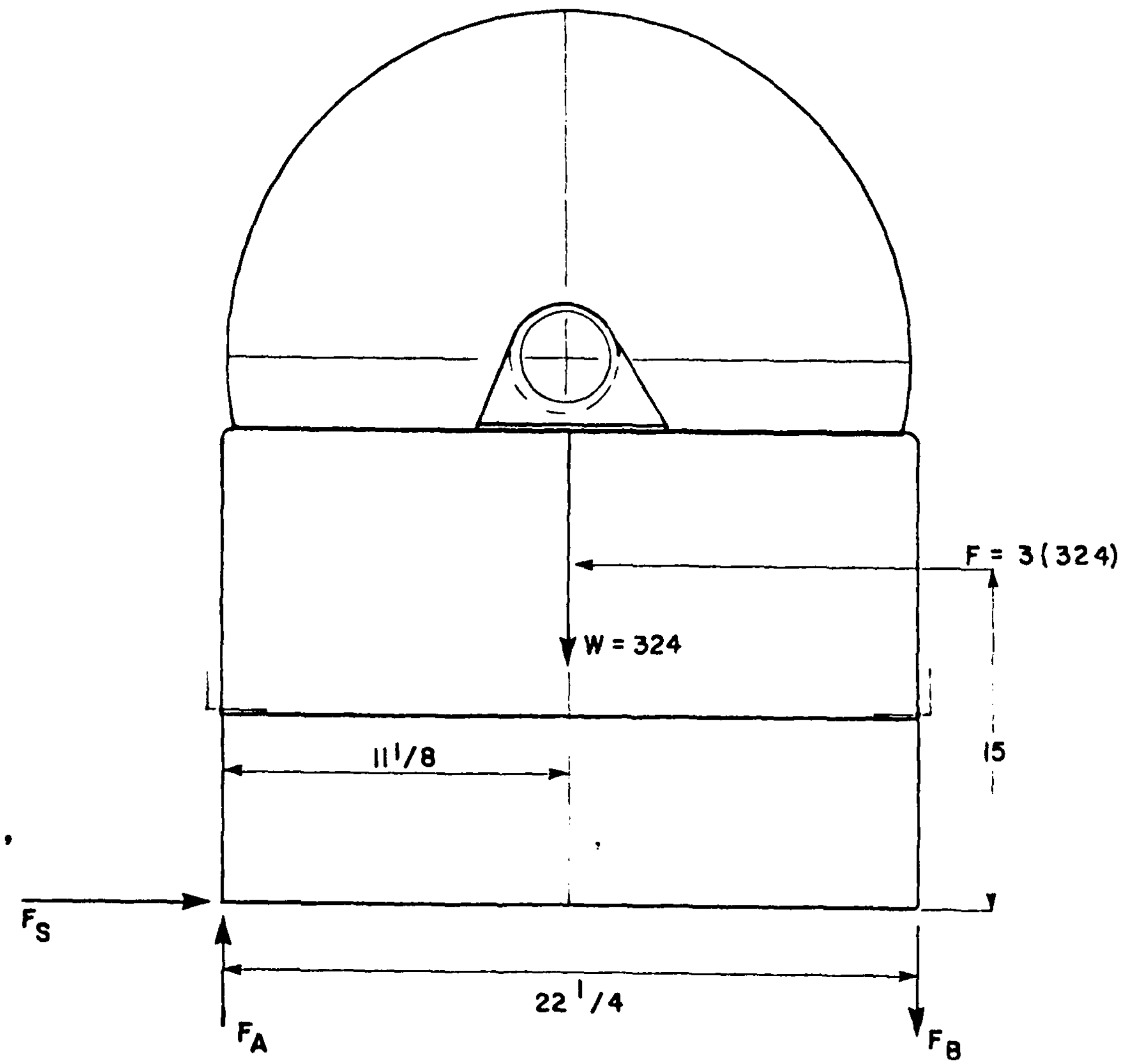

Figure-2 Shear Load On Bolts

b. Therefore, the tensile strength will now be examined (see Figure 2).

$M_{Left} = 0$

$-(1)(3)(162) + 5(F_{T_R}) = 0$ F_{T_R} = Tension load in right bolt

$\underline{F_{T_R} = 98 \text{ pounds}}$

$$\sigma = \frac{F_{T_R}}{A_S}$$

$$\sigma = \frac{98}{.069}$$

$\underline{\sigma = 1402 \text{ psi}}$

σ = Tensile stress

A_S = Stress area

The tensile stress is well below the 30.000 yield strength. Therefore, the bolts are satisfactory and acceptable.

c. The final area of concern in this calculation set is the legs on which the hose reel assembly are mounted (see Figure 1). These legs are constructed with 11 gauge (.120) carbon steel (1030). There is a shear force and a tensile force in this material (see Figure 3). Each leg is 20 - 3/4" long in the lateral direction.

$F_x = 0$

$F_{S_L} + F_{S_R} - 3(324) = 0$ $F_{S_R} = F_{S_R}$

$2 F_{S_R} = 3(324)$

Where F_{S_L} and F_{S_R} are shear forces on each leg.

F_{S_R} = 486 pounds

F_{S_L} = 486 pounds

Therefore:

$$\sigma = \frac{F}{A}$$

$$\sigma = \frac{486}{(20.75)(.120)}$$

σ = Shear stress

F = Shear force

A = area

$M_{Left} = 0$

$22.25\ (F_{T_R}) - 11\text{-}3/16\ (3)\ (.324)\quad 324\ (11\text{-}1/8) = 0$

$22.25\ (F_{T_R}) - 10874.25 + 3604.5 = 0$

$F_{T_R} = \frac{3590}{22.25}\ \frac{7269.75}{22.25}$

$F_{T_R} = \underline{326.8 \text{ pounds}}$

$F_y = 0$

$F_{T_L} - 324 - F_{T_R} = 0$

$F_{T_L} \underline{= 324 + 326.8 = 650.8 \text{ pounds}}$

Therefore:

$\sigma = \frac{F}{A}$

σ = Tensile stress
F = Tensile load
A = area

$\sigma = \frac{650.8}{(.120)\ (20.75)}$

$\sigma \underline{= 261.4 \text{ psi}}$

Therefore, the shear and tensile stresses are well below yield point in shear (15,000 psi) and in tensile (30,000 psi) and are, therefore, acceptable. For the bolts which secure the legs, the force of 650.8 pounds (tensile in the leg) acts on four bolts (stress area 0.0773 per bolt) for a bolt shear stress as follows:

$\sigma = \frac{650.8}{4.(0.0773)}$

$\sigma = 2104.8 \text{ psi}$

Again, well below the yield point of 15,000 psi shear for the steel in question.

2. <u>Calculation Set B - Lateral (Left or Right)</u> (Figure 4)

These calculations will consider a load (F) equal to 3 g applied parallel and horizontal to the hose reel axis. Force considered can be left or right as each direction will produce equal stress loads (F_{SL}, F_{SR}).

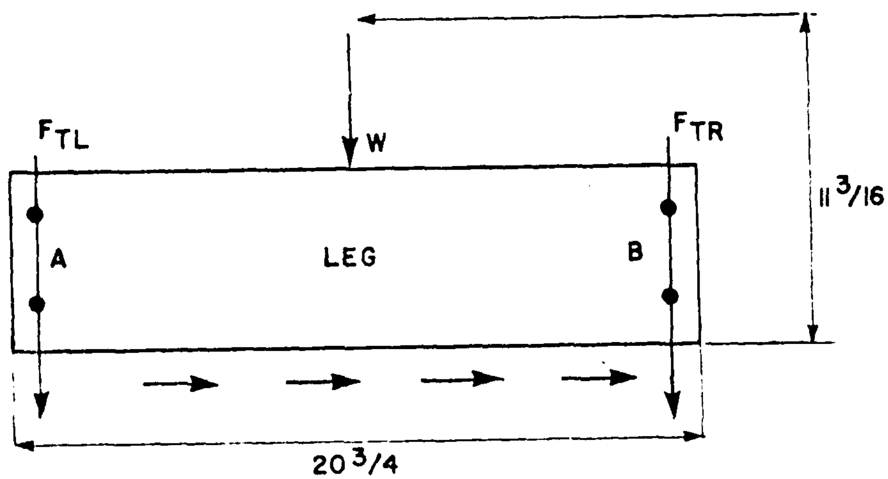

Figure-3 Legs To Mount Hose Reel Assembly

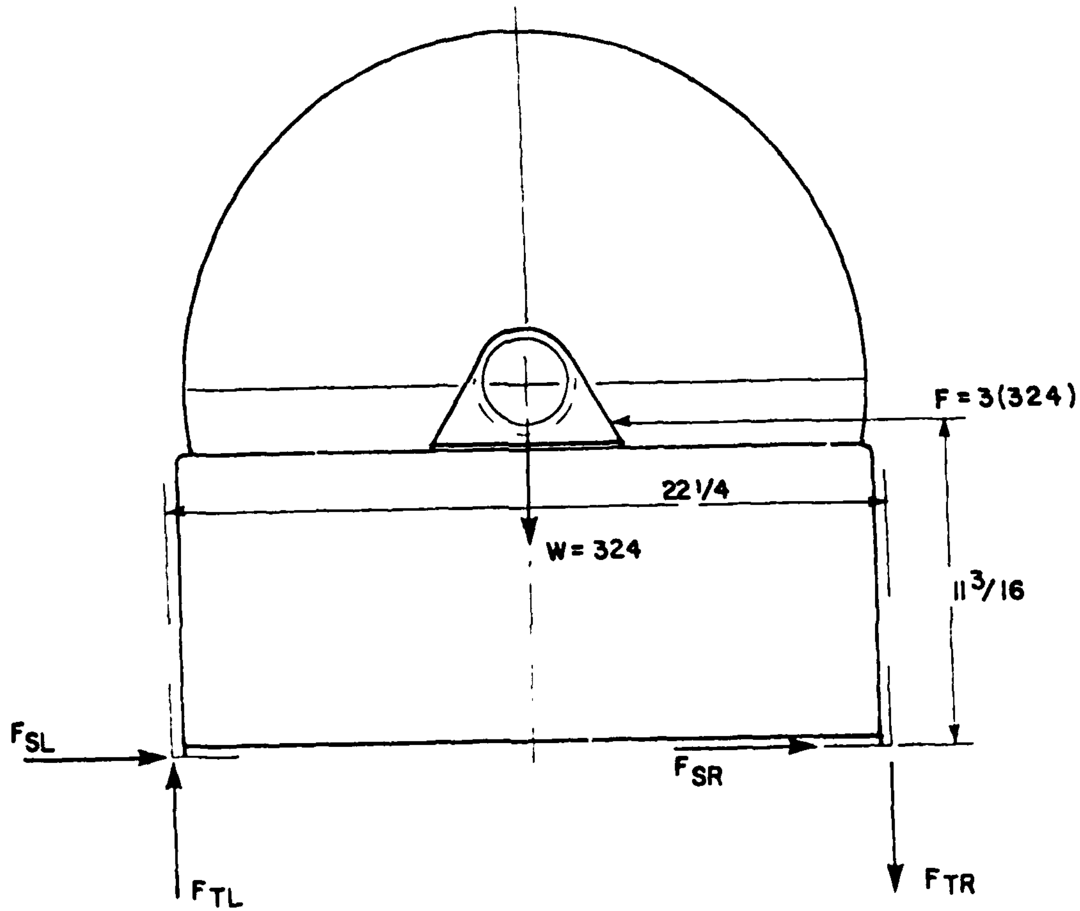

Figure-4 Calculation Set B-Lateral (Left or Right)

The bearings are designed to withstand an axial thrust of 588 pounds each. The total load on these bearings is equal to 3 (324)/2 or 486 pounds per bearing. Thus, the bearings can withstand the axial loading in the lateral direction.

The shear force in the lateral on the bearing bolts would be equal to the numerical value determined in Sub Section A.1.C. Therefore the bolts are satisfactory.

The remaining consideration in the lateral direction on the reel hose is the legs and the legs bolts (see Figure 4).

a. Shear Force on Leg

$F_x = 0$

F_s = Shear load on leg, but there are two legs

$3\ (324) = 2\ F_s$

σ = Shear stress

$F_s = \underline{486 \text{ pounds}}$

$= F_s/A$

A = Shear area

b. Shear stress in the bolts will be:

$$\sigma = \frac{F}{A_s}$$

σ = Shear stress

F = Load = $F_{S_{R/2}}$ since two Bolts share the load

$$\sigma = \frac{486/2}{0.0773}$$

A_s = Stress area

$$\sigma = \underline{3143.6 \text{ psi}}$$

Therefore, the stress loads (tensile and shear) on the 3/8 - 16 bolts is well below the yield strength for stainless steel material. Thus, these bolts are acceptable.

c. Bolt attachments between base and skid (Figure 7)

3/8 - 16 bolts are utilized

$M_A = 0$

$$12\ 1/2\ (324) - 26.2\ (3)\ (324) + 33\ (F_B) - 7.5\ (3)\ 243/4 = 0$$

$$F_B = \frac{26.2\ (3)\ (324) - 12\ 1/2\ (324) + 7.5\ (3)\ 24\text{-}3/4}{33}$$

$F_B = \underline{690 \text{ pounds}}$

$F_y = 0$

$F_A - F_B - 324 = 0$

$F_A = 690 + 324$

$F_A = \underline{1014 \text{ lbs}}$

$F_x = 0$

$-3 \frac{(243)}{4} - 3 (324) + F_S = 0$

$F_S = \underline{1154 \text{ pounds}}$

(1) The force F_B is a tensile load on the bolts while the force F_A is a compressive force on the skid. Force F_B (690 pounds) is shared by four bolts. The tensile stress is:

$$\sigma = \frac{486}{0.120\ (30.75)}$$

$$\sigma = \underline{132 \text{ psi}}$$

d. Shear Load on Bolts

$M_A = 0$

$(30.75)\ (F_{T_R}) + (15.375)\ (324) = 11.1875\ (3)\ \ (324)$

$$F_{T_R} = \frac{10874.25 - 4981.5}{30.75}$$

$$F_{T_R} = \frac{A_S}{191.7 \text{ lbs}}$$

$Fy = 0$

$F_{T_L} + F_{T_R} + 324 = 0$

$F_{T_L} = -F_{T_R} - 324 = 191.7 - 324$

$$F_{T_L} = \frac{A_S}{515.7}$$

Therefore, the maximum load is on the bolts on the left end. There are two bolts per leg at each end and there are two legs. Therefore, the load is carried by four bolts. Thus:

$$\sigma = \frac{F_{T_L}}{4A_S} \qquad A_S = \text{Stress area} = .0773$$

$$\sigma = \frac{515.7}{4.(0.0773)}$$

$$\sigma = \underline{1667.85 \text{ psi}}$$

Again, far below the yield strength of 15,000 psi on 1030 steel.

3. Calculation Set C - Up

This calculation set will consider a force equal to 2 g acting perpendicular to the reel axis in the up direction. The load is equal to 2 (324) or 648 pounds. The bearings can each withstand 2,940 pounds of radial thrust. Thus, the bearings are acceptable for this loading condition.

a. Each bearing is secured by two bolts (3/8 - 16) or four bolts restrain the 324 pound load. Thus:

$$\sigma = \frac{324}{4A_s} \qquad A_s = \text{Stress area}$$

$$\sigma = \frac{320}{4(0.0773)} \qquad \sigma = \text{Tensile area}$$

$$\sigma = 1035 \text{ psi}$$

Again, the stress is well below the yield point of 30,000 psi. Final consideration would be the bolts which secure the legs. However, these bolts are 3/8 - 16 as above, with eight bolts restraining the 324 pound load instead of four bolts as in the bearings. Therefore, these bolts are acceptable.

4. Calculation Set D - Down (Figure 5)

This calculation set will consider a force equal to 4 1/2 acting perpendicular to the reel axis in the down direction. The force is equal to 4.5 (324) or 1458 pounds. The bearings can withstand a force of 2940 pounds in the radial direction.

The legs are the only other support members to be considered in this calculation.

Thus:

$$\sigma = \frac{F}{8A_s} \qquad \sigma = \text{Shear stress}$$

$$\sigma = \frac{1458}{8\ (0.0773)} \qquad A_s = 0.0773$$

$$F = 1458$$

$$\underline{\sigma = 2357.8 \text{ psi}}$$

Again, this shear stress is well below the shear yield strength of 15,000 psi.

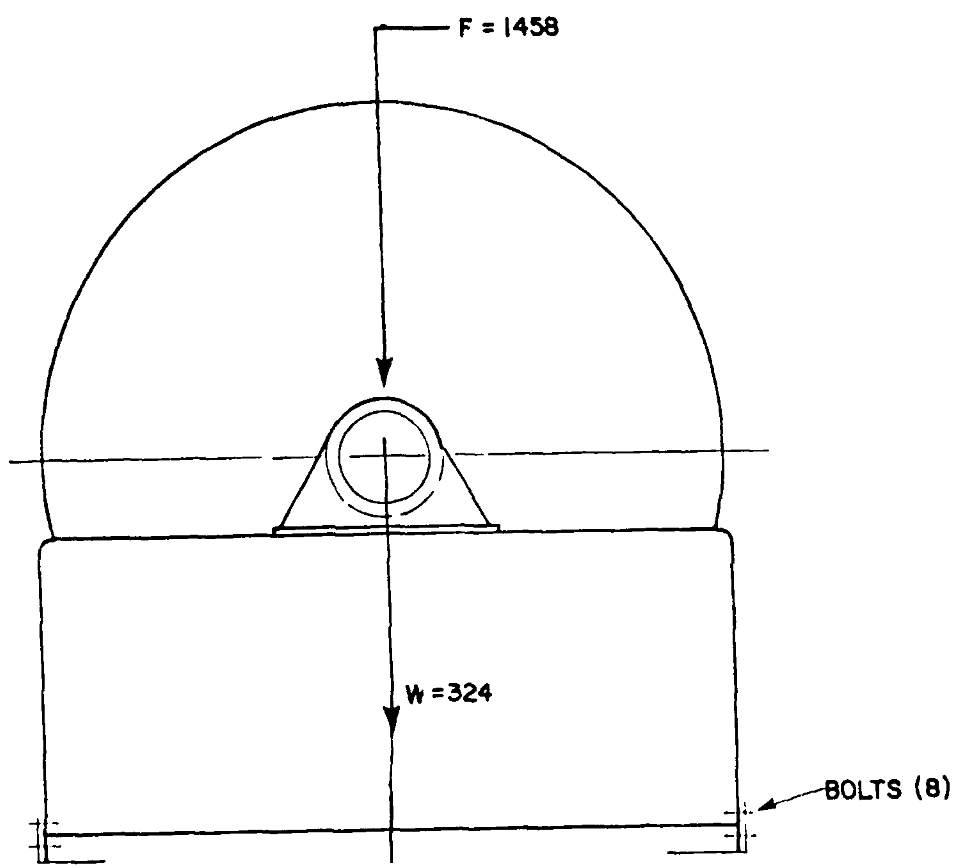

Figure-5 Calculation Set D-Down

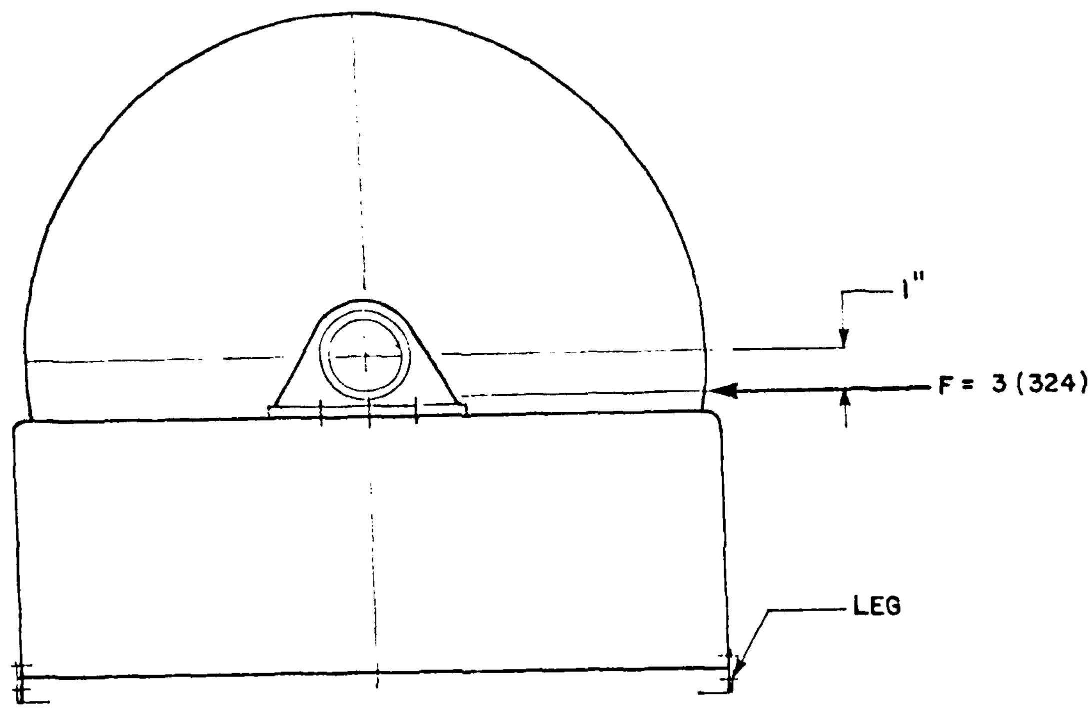

Figure-6 Bolt Attachment Between Reel and Base

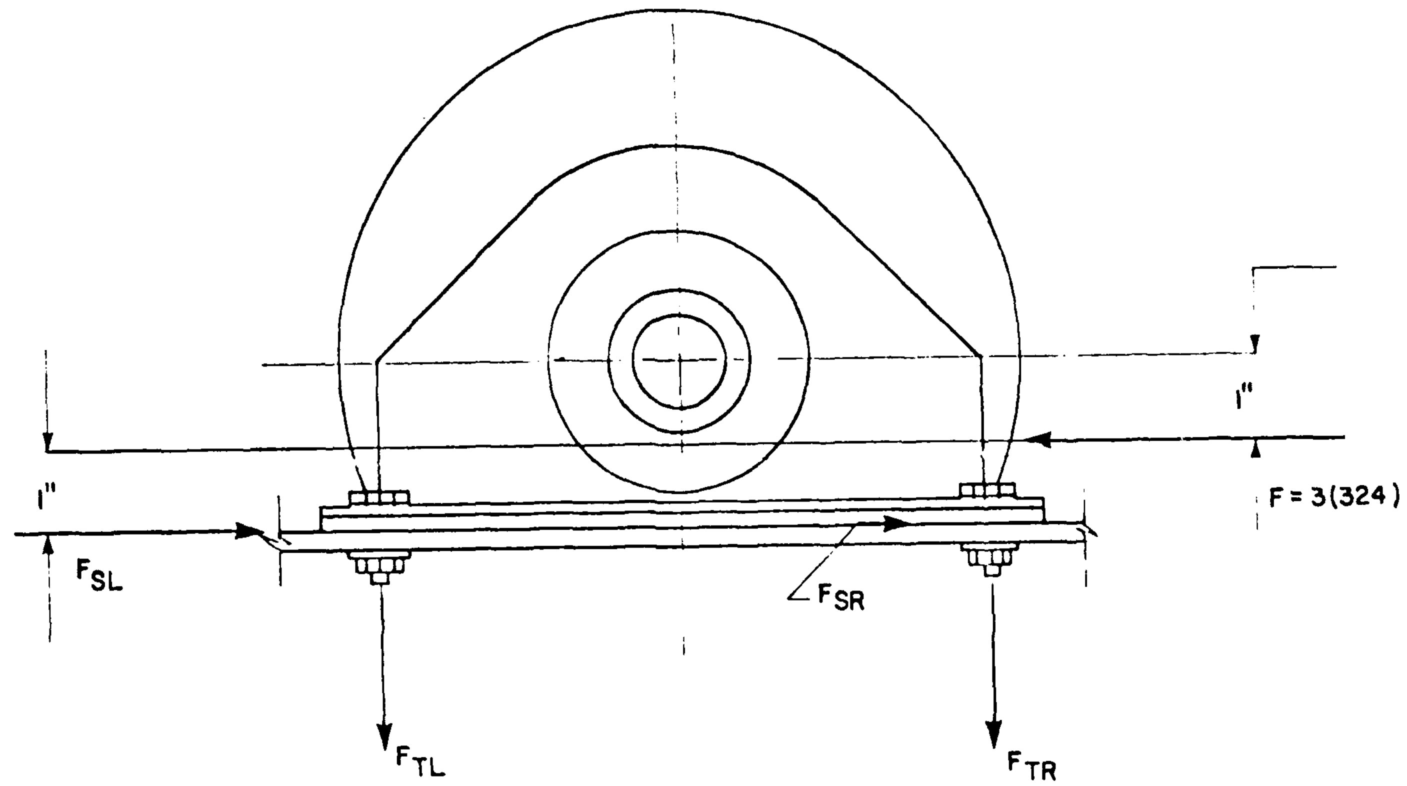

Figure-7 Bolt Attachment Between Base and Skid

Finally, the load is also supported by the leg. Therefore:

$$\sigma = \frac{F + W}{2\ (A)}$$

two legs

F = Force (1458)
W = Weight 324
A = Area

$$\sigma = \frac{1458 + 324}{2(20.75)\ \ (0.120)} \qquad \frac{1782}{4.98}$$

$$\sigma = \underline{357.85 \text{ psi}}$$

Therefore, the leg design is acceptable.

HOSE REEL ASSEMBLY ATTACHMENT MOUNTING BOLTS - Sub Section B

1. <u>Calculation Set A - Fore and Aft Direction</u>

A force equal to 3 g will be applied to the hose reel assembly perpendicular to the reel axis of rotation in the horizontal direction fore or aft. Calculation will be done in the fore direction with numerically equal results in the aft. There are two sets of mounting bolts to consider --- one set attaches the reel assembly to the hose reel base (see drawing 36225 and Figure 6) and the other attaches the hose reel base to the skid (see Figure 7).

The base will carry the load of two hose reels. We will assume the hose reels are free standing and will ignore the added strength of the rapid piping.

2. <u>Bolt Attachments Between Reel & Base (Figure 6)</u>

3/8 - 16 bolts are utilized

$$M_{Left} = 0$$

$$25\ (F_{T_R}) - 11\text{-}3/16\ (3)\ (324) + 324\ (12\ 1/2) = 0$$

$$F_{T_R} = \frac{10875 - 4050}{25}$$

$$F_{T_R} = 273 \text{ lbs}$$

$$F_y = 0$$

$$F_{T_L} - 324 - F_{T_R} = 0$$

$$F_{T_L} = 324 + 273$$

$$F_{T_L} = 597 \text{ lbs}$$

$Fx = 0$

$F_{S_L} + F_{S_R} - 3\ (324) = 0$

$2F_{S_R} = 3\ (324)$

$F_{S_L} = F_{S_R}$

Where F_{S_L} and F_{S_R} are shear forces on each bolt.

$F_{S_R} = F_{S_L} = 486$ pounds

a. The load F_{T_R} is a tensile load on the bolts while F_{T_L} is a compressive load on the base stand. The load F_{T_R} (273 pounds) is shared by two bolts. Thus:

$$\sigma = \frac{F}{A_S}$$

σ = Bolt tensile stress
F = Bolt load $F_{T_R}/2$

$$\sigma = \frac{273/2}{.0773}$$

A_S = Stress area = 0.077

$$\underline{\sigma = 1765.9\ \text{psi}}$$

The shear stress on the bolts is:

$$\sigma = \frac{F_S}{8A_S}$$

σ = Shear stress
F_S = Shear force

8 bolts share load

$$\sigma = \frac{1154}{8\ (.0773)}$$

$$\underline{\sigma = 1866\ \text{psi}}$$

Therefore, the stress loads (tensile and shear) on the 3/8 - 16 bolts is well below the yield strength for stainless and steel material. Thus, these bolts are acceptable.

b. <u>Shear and Bending of Hose Reel Base</u>

Ignoring the added strength of the rigid piping, we will examine the vertical members of the hose reel base assembly for shear and bending.

We will assume the shear force on the members is identical to the bolt shear force of 577 pounds. Two angles will absorb each force. Therefore:

$$\sigma = \frac{F_{SL}}{A}$$

σ = Shear stress
A = Shear area of angle

$$\sigma = \frac{577}{2\ (.94)}$$

$\underline{\sigma = 307\ \text{psi}}$

c. For bending stress we will assume each angle to be a cantilever beam supporting the weight of the hose reels and the base assembly. Four (4) beams will support the total weight.

$$S_B = \frac{M}{4Z}$$

S_B = Stress in bending
M = Moment
$Z = \frac{I}{C}$ = angle properties

$M = 0 \quad M - 15\ (3)\ (324) - 7.5\ (3)\ 243/4 = 0$

$\underline{M = 15946 \text{ in pounds}}$

d. Shear stress in the bolts will be:

$$\sigma = \frac{F}{A_S}$$

σ = Shear stress
F = Load = $F_{S_{R/2}}$ since two bolts share the load
A_S = Stress area

$$\sigma = \frac{486/2}{0.0773}$$

$\underline{\sigma = 3143.6 \text{ psi}}$

Therefore, the stress loads (tensile and shear) on the 3/8 - 16 bolts is well below the yield strength for stainless steel material. Thus, these bolts are acceptable.

e. Bolt attachments between base and skid (Figure 7)

3/8 - 16 bolts are utilized

$M_A = 0$

$12\ 1/2\ (324) - 26.2\ (3)\ (324) + 33\ (F_B) - 7.5\ (3)\ 243/4 = 0$

$$F_B = \frac{26.2\ (3)\ (324) - 12\ 1/2\ (324) + 7.5\ (3)\ 243/4}{33}$$

$\underline{F_B = 690 \text{ pounds}}$

$F_y = 0$

$F_A - F_B - 324 = 0$

$F_A = 690 + 324$

$F_A = 1014 \text{ lbs}$

$F_x = 0$

$-3\ \frac{243}{4} - 3\ (324) + F_S = 0$

$\underline{F_S = 1154 \text{ pounds}}$

(1) The force F_B is a tenile load on the bolts while the force F_A is a compressive force on the skid. Force F_B (690 pounds) is shared by four bolts. The tensile stress is:

$\sigma = F/A_S$ — σ = Bolt tensile stress

$\sigma = \frac{690}{.0773/4}$ — F = Bolt load = $F_B/2$

A_S = Stress area = $^B0.0126$

$\sigma = \underline{2231.5 \text{ psi}}$

$S_B = \frac{15975 = 15946 \text{ psi}}{4\ (.25)}$

This is the highest stress produced through out the assembly and still well within the properties of the steel.

3. <u>Calculation Set B - Lateral Direction: Left and Right</u>

These calculations will consider a load equal to 3g applied parallel to the axis of rotation of the hose reel --- force can be applied either left of right directions without changing the maximum numerical stress. There are two sets of mounting bolts to consider --- one set attaches the reel assembly to the hose reel base (see drawing 36225 and Figure 8) and the other attaches the hose reel base to the skid (see Figure 9).

4. <u>Bolt Attachments Between Reel and Base (Figure 8)</u>

3/8 - 16 bolts are utilized

$M_A = 0$

$14.5\ (324) - 29\ (F_B + 14\ (3)\ (324) = 0$

$F_B = \frac{(14)\ (3)\ (324) + 14.5\ (324)}{29}$

$F_B = 631.3$ pounds

$Fy = 0$

$F_A + W - F_B = 0$

$F_A = 631.3 - 324$

$\underline{F_A = 307.3 \text{ pounds}}$

$F_X = 0$

$F_X - 3\ (324) = 0$

$\underline{F_S = 972 \text{ pounds}}$

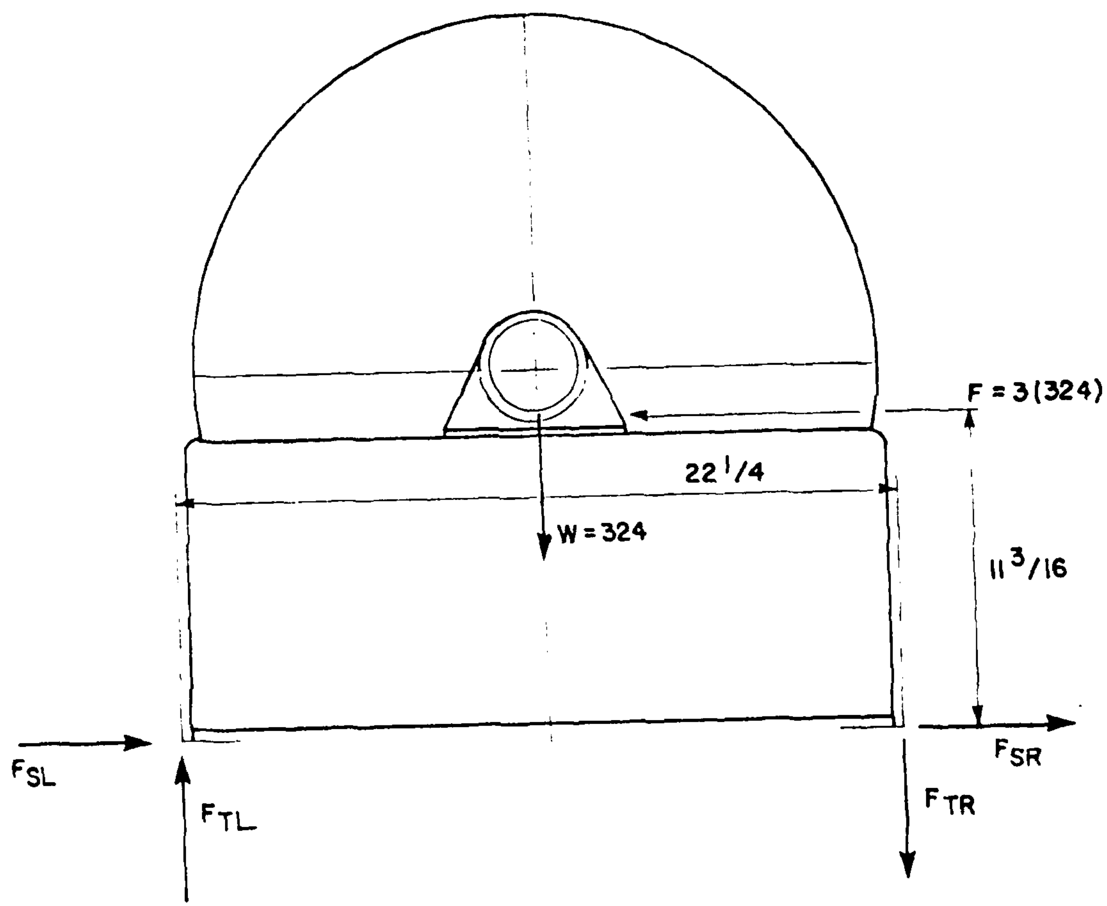

Figure-8 Bolt Attachment Between Reel and Base

a. The force F_A is a tension force applied to the bolts while F_B is a compressive force on the base. Therefore, the tensile stress on the bolts is:

$$\sigma = \frac{F}{A_S}$$ σ = Bolt tensile stress

$$\sigma = \frac{307.3/2}{0.0773}$$ $F = F_A/2$ (force on each bolt)
A_S = Stress area

$$\underline{\sigma = 1988 \text{ psi}}$$

b. Shear stress is:

$$\sigma = \frac{F1}{A_S}$$ σ = Shear stress
F1 = $F_S/4$ (4 bolts are sharing shear load which is F_S)

$$\sigma = \frac{972/4}{0.0773}$$ A_S = Stress area

$$\sigma = 3143.6 \text{ psi}$$

Therefore, both the shear stress and the tensile stress on the 3/8 - 16 bolts are well below the yield strength of stainless steel.

5. <u>Bolt Attachments Between Base and Skid</u> (see Figure 9)

3/8 - 16 bolts are utilized

$$M_C = 0$$

$$29\ (324) + 14.5\ (324) + 26.2\ (3)\ (324) + 7.5\ (3)\ 24\text{-}3/4 = 0$$

$$F_D = \frac{29\ (324) + 14.5\ (324) + 26.2\ (3)\ (324) + 7.5\ (3)\ 24\text{-}3/4}{29}$$

$$F_D = \underline{1411 \text{ pounds}}$$

$$Fy = 0$$

$$F_c + 220 - F_c = 0$$

$$F_c = 1411 - (324 + 243/4)$$

$$\underline{F_c - 1026 \text{ pounds}}$$

$$F_x = 0$$

$$F_{S_1} - 3\ (324) - 3\ (243/4) = 0$$

$$\underline{F_{S_1} = 1154 \text{ pounds}}$$

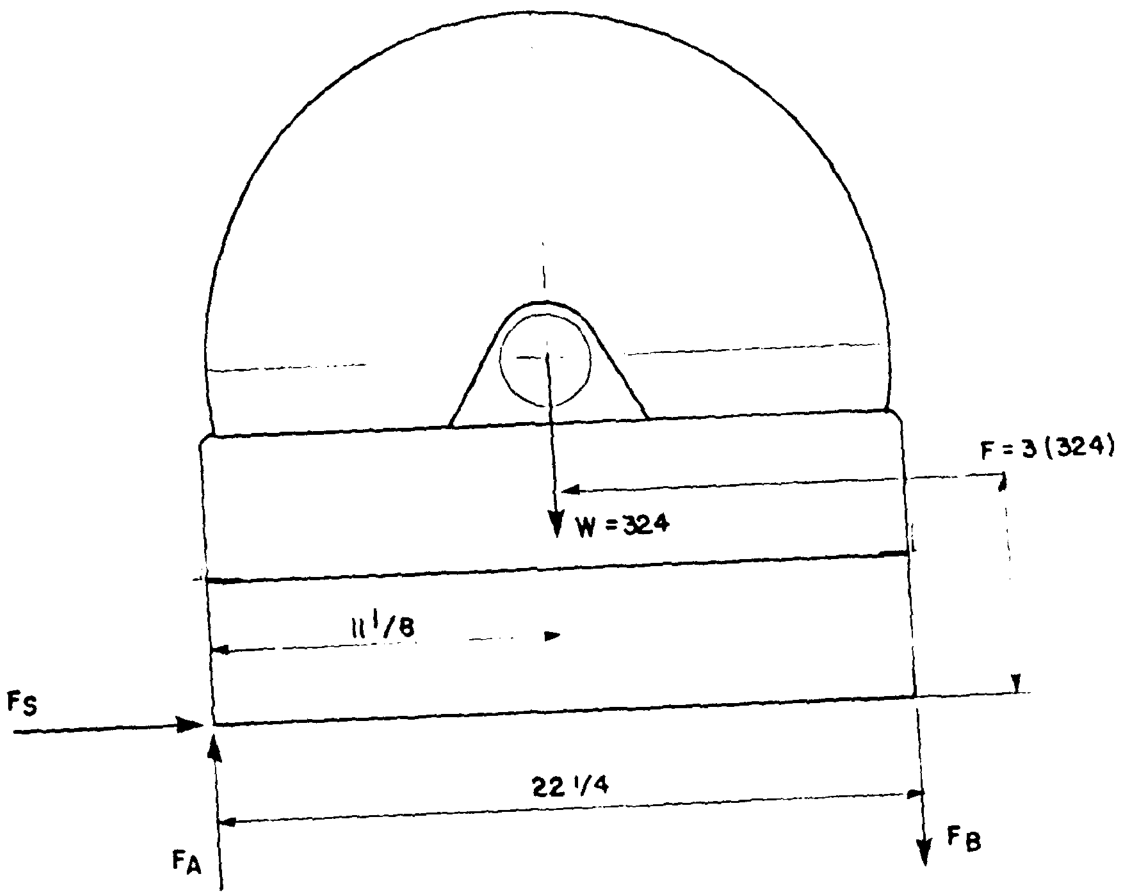

Figure-9 Bolt Attachment Between Base and Skid

a. The force F_D is a compression force on the skid and the force F_c is a tensile force on the 3/8 - 16 bolts. Therefore, the maximum tensile stress on the bolts assuming only two will hold the entire unit is:

$$\sigma = F/A_S$$

$$\sigma = \frac{1026/2}{.0773}$$

$$\underline{\sigma = 6636.5 \text{ psi}}$$

σ = Bolt tensile stress
F = $F_c/2$ (force on each bolt)
A_S = Stress area

b. Shear stress is:

$$\sigma = F_1/A_S$$

$$\sigma = \frac{1154/8}{.0773}$$

$$\sigma = 1866 \text{ psi}$$

σ = Shear stress
$F1$ = $F_{S1}/8$ - 8 bolts are sharing shear load which is F_{S_1}

Therefore, both the shear stress and the tensile stress on the 3/8 - 16 bolts are well below the yield strength of stainless steel. The shear and bending loads on the vertical base members will be identified to the fore and aft calculations, Section II, Calculations Set A.

6. Calculation Set C - Up Direction

These calculations will consider a load equal to 2 g applied perpendicular to the axis of rotation of the hose reel in the up direction. There are two sets of mounting bolts to consider --- one set attaches the reel assembly to the hose reel base (see drawing 36225 and Figure 10) and the other attaches the hose reel base to the skid (see Figure 11).

a. Bolt Attachments Between Reel and Base (Figure 10)

3/8 - 16 bolts are utilized.

Since the force is applied at a center of gravity which is equal distance from the four bolts, the bolts will share the load equally. Therefore:

$$F_y = 0$$

F_{Bolt} - Load on four bolts

$$F_{Bolt} + 324 - 2\,(324) = 0$$

$$F_{Bolt} = 324 \text{ pounds}$$

$$\sigma = \frac{324}{4A_S}$$

A_S = 0.0773

4 bolts

$$\sigma = 1048 \text{ psi}$$

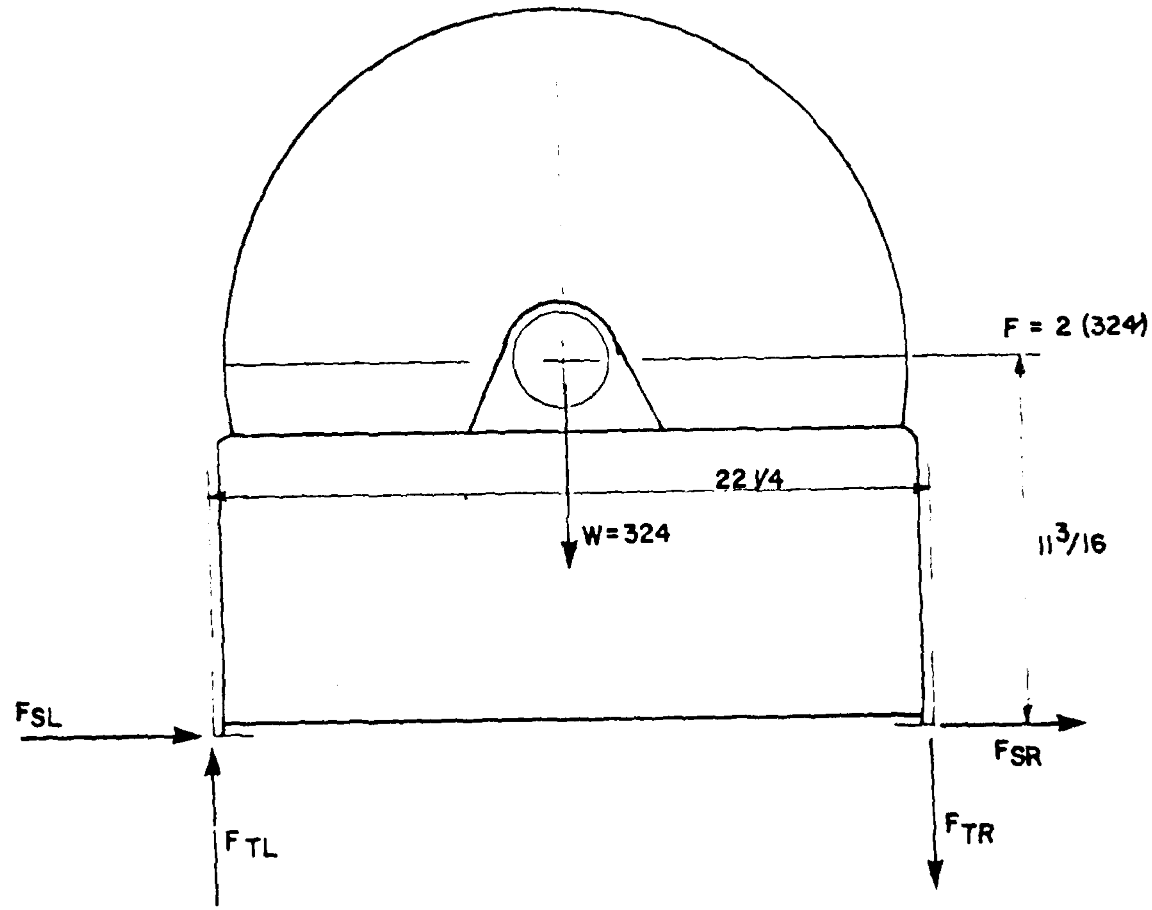

Figure-10 Bolt Attachment Between Reel and Base

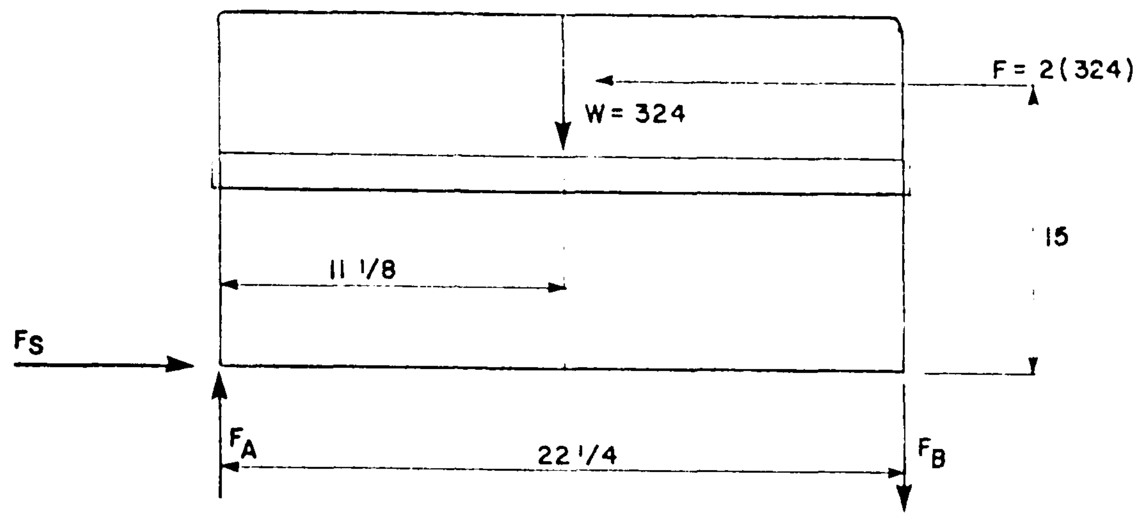

Figure-11 Bolt Attachment Between Base and Skid

b. <u>Bolt Attachments Between Base Skid</u> (Figure 11)

3/8 - 16 bolts are utilized.

Since force is applied at a center of gravity which is equal distance from the eight bolts, the bolts will share the load equally. Therefore:

$$F_y = 0$$

$$F_{Bolt} = 385 - 2\,(385) = 0$$

$$\underline{F_{Bolt} = 385}$$

$$\sigma = \frac{385}{8A_S} \qquad A_S = .0773$$

8 bolts

$$\sigma = \underline{622 \text{ psi}}$$

Therefore, the tensile stress on the 3/8 - 16 bolts is well below the yield strength of stainless steel.

7. <u>Calculation Set D - Down Direction</u>

A force equal to 4 1/2g will be applied to the unit in a down direction perpendicular to the agent tank base plate. This force direction does not exert any forces on the bolt attachments, and therefore, is not a factor in the calculations required by MIL-T-83303A.

APPENDIX B

PARTS INDEX

Parts needed for modification of the AS 32/P-13

55589 350 PKP dry chemical 500-Halon 1211 skid ass'y - modified one man operation (USAF P-13 skid ass'y).

- 2372 1/8" x 1" flat steel (3)
- 36237 Skid frame
  - 19124 3/8 x 1-1/4 bolt s.s.
  - 16580 6" x 10.5 lb/ft channel (82" lg) (2)
  - 17469 4" x 5.4 lb/ft channel (44" lg) (6)
  - 16365 "X" frame
  - 2987 2" x 2" x 1/4" angle (44" lg)
  - 2987 2" x 2" x 1/4" angle (18" lg)
  - 8988 1/4" x 2" flat steel (6" lg) (2)
  - 8988 1/4" x 2" flat steel (12-1/2" lg)
  - 8988 1/4" x 2" flat steel (6-1/2" lg)
  - 23845 1/2" x 2" flat steel (17-1/4" lg)
  - 23845 1/2" x 2" flat steel (15" lg)
  - 36228 Paint specifications
- 36234 Dry chemical tank and piping
  - 29924 Vendor's tank
    - 19404 Collar (Ansul supplied)
    - 29922 Gas tube assembly (Ansul supplied)
      - 2431 1/2" wrought steel pipe (5" lg)
      - 29921 Gas Tube
        - 29920 Pipe (Drilled)
          - 2462 1/2" wrought steel pipe (15" lg)
        - 3288 Clamp
        - 25508 Disc
        - 3287 Valve rubber
      - 10935 1/2" Malleable tee
      - 2462 1/2" Wrought steel pipe (12-1/2" lg)
  - 26312 Indicator fill cap
  - 16090 1" x 5" Lg nipple (2)
  - 19962 1/2" tee (2)
  - 16088 1/2" x 4" lg nipple (2)
  - 16198 1/2" close nipple
  - 26001 1/2" ball valve (2)
  - 26013 Safety valve
  - 23850 Ring pin bracket assembly
    - 1133 1/4" Lockwasher
    - 18107 1/4" - 20 Hex nut
    - 1132 1/4" - 20 x 3/4" Lg rd head machine screw
    - 2985 1/2" sq. steel (1-1/2" lg)
    - 2986 1/8" x 1/2" flat sheet (6-1/2" lg)
    - 36228 Paint specifications
  - 19838 1/2" x 90° street elbow (2)
  - 19836 1/2" x 1-1/2" lg. nipple (2)
  - 19872 1" tee
  - 31782 1" x 90° union elbow
  - 26002 1" ball valve
  - 26000 1/4" ball valve

	19190	1/4" close nipple
	19994	Bracket nameplate
	19992	Bracket nameplate
	19993	Bracket nameplate
	598	Ring pin (4)
	2367	Safety chain (4)
	25540	Pop rivet (6)
	25464	1/2" x 1/4" reducing bushing (2)
	36228	Paint specifications
	16196	1/2" union elbow
	19873	1" x 1/2" reducing bushing
	19958	1/2" pipe (23" lg)
	197	Lead and wire seal (4)
55660	Halon 1211 tank and piping	
	36229	Vendor's tank
	54286	3/4" Ball valve
	30263	Fill gage
	26001	1/2" ball valve (2)
	26000	1/4" ball valve
	16198	1/2" close nipple (3)
	19836	1/2" x 1-1/2" nipple (2)
	25464	1/2" x 1/4" reducing bushing
	28124	1/2" cross
	26013	Pressure relief valve
	19833	3/4" x 90° elbow (3)
	19853	3/4" pipe (5" lg)
	19853	3/4" pipe (8-1/4" lg)
	19116	3/4" close nipple
	19853	3/4" pipe (13-3/8" lg)
	19853	3/4" pipe (6" lg)
	19846	3/4" x 3/4" x 1/2" reducing tee
	16196	1/2" union elbow
	19993	Bracket nameplate
	19994	Bracket nameplate
	19992	Bracket nameplate
	598	Ring pin (3)
	2367	Safety chain (3)
	25540	Pop rivet (6)
	19838	1/2" x 90° street elbow (2)
	19958	1/2" pipe (17-1/4" lg)
	26031	1/2" charging coupling
	26148	Dust cap
	19772	1/2" check valve
	19962	1/2" tee
	16195	Union elbow
	19190	1/4" close nipple
	36228	Paint specifications
	197	Lead and wire seal (3)
	19853	3/4" pipe (2-1/2" lg)
	1738	2" pipe plug (2)
55588	Hose reel base assembly	
	36037	Hose reel base

2987 2 x 2 x 1/4 angle (12-3/4 lg) (4)
2987 2 x 2 x 1/4 angle (45-1/2 lg) (2)
2987 2 x 2 x 1/4 angle (18-1/4 lg) (2)
8988 2 x 1/4 flat stock (22-1/4 lg) (2)
8988 2 x 1/4 flat stock (46 lg) (2)
8988 2 x 1/4 flat stock (12-3/4 lg) (2)
2985 1/2" square stock (3/4 lg) (2)
2987 Angle
36228 Paint specifications

55674 Hose reel ass'y

- 55595 Electric hose reel
  - 19273 Hose reel
  - 12532 Swivel adaptor union
  - 16159 Swivel adaptor union
  - 19861 1-1/2 x 1 reducing bushing (2)
  - 36228 Paint specifications
- 55659 Roller base assembly
  - 55658 Roller base
    - 2396 3/8 x 3 flat
  - 55655 channel
    - 8940 2 x 1 x 1/8 hot rolled mild steel channel
  - 55656 channel
    - 8940 2 x 1 x 1/8 hot rolled mild steel channel
  - 36228 Paint specifications
- 17586 Hose roller assembly
- 55624 Hose confiner
  - 19939 1/2 aluminum rod
  - 36228 Paint specifications
- 16121 1/2" lockwasher ss (4)
- 16119 1/2" hex nut ss (6)
- 19124 3/8 x 1-1/4 bolt (4)
- 14928 3/8 hex nut ss (6)
- 14929 3/8 lockwasher ss (6)
- 16618 3/8 flat washer (6)
- 19686 Hose clamp (4)
  - 2538 1/8 x 1-1/4 flat steel
- 1132 1/4 x 3/4 screw (8)
- 1133 1/4 lockwasher (8)
- 18107 1/4 hex nut (8)
- 55709 Halon 1211 hose assembly
  - 31213 1" I.D. x 50' hose
  - 55708 1" hose coupling
- 55859 D.C. hose assembly
  - 11384 hose
  - 2131 male coupling
  - 55708 Hose coupling
- 19428 Clip - crank handle (3)
- 3855 #10 Screw (3)
- 14235 #10 Lockwasher (3)
- 14732 #10 Hex Nut (3)

36231	100 cu. ft. nitrogen cylinder	
	197	Lead and wire seal (2)
	17262	Valve locking assembly
	1625	Tag wire
	15389	Tag
	1423	D.O.T. caution tag
	11391	Label
	25128	Label
	3477	Label
	2367	Chain (20 links)
	52698	Charged nitrogen cylinder
	19897	Cable tie
	36228	Paint specifications
36230	300 cu. ft. nitrogen cyclinder	
	36043	Charged nitrogen cylinder
		25125 Quick Opening valve
		11453 Shipping Plug
		11392 N_2 cylinder cap
		28281 Nitrogen Cylinder
	197	Lead and wire seal (2)
	17262	Valve locking assembly
	11391	Label
	2367	Chain (20 links)
	15389	Tag
	19897	Cable Tie
	1625	Tag wire
	1423	D.O.T. caution tag
	25128	Label
	12011	Label
	36228	Paint specifications
25462	Nitrogen hose (L.P.) (2)	
7787	Nitrogen hose (H.P.)	
3382	Nitrogen hose (H.P.)	
4070	Patent plate	
687	Drive pin (2)	
55620	Valve handle	
	2186	Valve handle machined
		12283 handle casting
3112	Valve extension rod bushing	
3113	1/2" conduit lock nut	
2537	1/2" D. Rod (62" lg)	
598	Ring Pin	
2367	Safety Chain	
15609	#4 - 40 x 3/4" Lg. Hex Head Screw	
197	Lead and Wire Seal	
14798	Regulator (2)	
	25590	Stud (2)
36239	Cylinder Roller (3)	
	19940	Ball Transfer (2)
	25540	Pop Rivet (4)
	2396	3" x 3/8" Flat Steel (9-1/4" Lg)
	36228	Paint Specifications

36045	Cylinder End Plate	
	16166	8" x 1/4" Flat Steel (10-1/8" Lg)
	36228	Paint Specifications
36044	Cylinder End Plate	
	16166	8" x 1/4" Flat Steel (11-21/32" Lg)
	36228	Paint Specifications
16121	1/2" Lockwasher (S.S.) (8)	
16119	1/2" - 13 Hex Nut (S.S.) (10)	
16512	3/8" - 16 x 1-1/2" Lg Cap Screw (S.S.) (12)	
14928	3/8" Hex Nut (S.S.) (16)	
14929	3/8" Lockwasher (S.S.) (16)	
16618	3/8" Flat Washer (S.S) (36)	
26520	3/16" x 5/16" Lg Pop Rivet (S.S.) (8)	
17281	1/2" x 3/8" Reducing Bushing (2)	
30245	1/2" x 45° Elbow (2)	
25582	Swivel Adaptor Union (2)	
16117	1/2"-13 x 1-1/2" Lg Hex Head Bolt (S.S.) (8)	
17486	1/2" Flat Washer (S.S.) (8)	
16514	1/4"-20 x 1-1/2" U Bolt (S.S.) (7)	
1133	1/4" Lockwasher (S.S.) (6)	
18107	1/4"-20 Hex Nut (S.S.) (6)	
19853	3/4" Pipe (49" Lg)	
19875	1" Pipe (26" Lg)	
19958	1/2" Pipe (27-3/4" Lg)	
36042	Nameplate	
34709	Nameplate	
34708	Nameplate	
36227	Nameplate	
36226	Nameplate	
19958	1/2" Pipe (58" Lg)	
36038	Cylinder Roller (3)	
	19940	Ball Transfer (2)
	25540	Pop Rivet (4)
	2396	3" x 3/8" Flat Steel (10" Lg)
	36228	Paint Specifications
36235	Nameplate - Identification	
36236	Nameplate - Transportation	
36036	Nameplate - Warranty	
26147	Recharge Carton	
26072	Charging Valve (2)	
16122	1/4" x 2" Lg Nipple (2)	
36041	Machined Tee (2)	
	36228	Paint Specifications
19124	3/8" x 1-1/4 Bolt (8)	
55502	Actuation Line Assembly	
	32739	Remote Actuator For balance of details see actuating device shipping assembly, 32739
	19112	1/4" O.D. PVC Covered Copper Tube
	55472	Valve Actuator
	36228	Paint Specifications
	16477	1/4 Tube x 1/4 NPT Male Connector (6)

- 19173 1/4 Tee (2)
- 11580 Hose (2)
- 11160 Quick Opening Valve Actuator (2)
  Refer to accessories index Page 56 for details
- 16645 1/4 x 90 Street Elbow
- 13797 Safety Relief Valve
- 55686 Oil Hole Cover
- 19407 Elbow
- 11718 Male Elbow
- 19111 Bushing
- 1732 1/8 NPT Poppet Valve
- 19968 1/4 Elbow Brass (2)
- 16138 1/4 Brass Pipe 15" Lg
- 16138 1/4 Brass Pipe 8" Lg
- 19172 1/4 x 1-1/2 Lg Brass Nipple
- 16138 1/4 Brass Pipe 2" Lg

55469 Twin Agent Nozzle
- 55875 D.C. Nozzle Sub-Assembly
  - 55874 Nozzle Body, Coated
    - 53084 Nozzle Body, Machined
    - 55819 Hard Lube Coating Specifications
  - 55873 Trigger Assembly
    - 55872 Trigger Coated
      - 53455 Trigger Machined
        - 54010 Trigger Casting
      - 55819 Hard Lube Coatings Specs.
    - 53848 Pins (2)

  For balance of details refer to over/under twin agent nozzle assembly (commercial) 54735
- 53091 Insert
- 13903 O-Ring
- 8105 Gasket (3)
- 55706 Nozzle Body, Coated
  - 55503 Nozzle Body
    - 31844 Aluminum Rod
  - 55819 Hard Lube Coating Specifications
- 55878 Bent Pipe, Coated
  - 54281 Bent Pipe
    - 53086 1" Sch. 40 Aluminum Pipe
  - 55819 Hard Lube Coating Specifications
- 24713 Coupling (S.S.)
- 54864 Set Screw (2)
- 55718 Halon Nozzle Sub-Assembly
  - 55717 Compression Spring
  - 55858 Nozzle Body, Coated
    - 53088 Nozzle Body, Machined
      - 53010 Nozzle Body, Casting
    - 55819 Hard Lube Coating Specifications
  - 53909 Shaft - Chrome Plate
    - 53085 Shaft
    - 9515 Chrome Plate Specifications

```
                        55873  Trigger Assembly
                               55872  Trigger Coated
                                      53455  Trigger Mounted
                                             54010  Trigger Casting
                                      55819  Hard Lube Coating Specs.
                               53848  Pin (2)
                               For balance of details, refer to
                               Mobil Oil twin agent nozzle assembly,
                               53082 D.C. nozzle P/N 53083
           55848        Halon Nozzle Body - Coated
                        55621  Nozzle Body - Machined
                               31844  Aluminum Rod
                        55819  Hard Lube Coating Specifications
           55856        Barrel, Coated
                        55596  Barrel
                        55819  Hard Lube Coating Specifications
           3902         Adaptor
           26144        Free Swivel Adaptor
           55587        Adaptor Coated
                        55622  Adaptor
                        55819  Hard Lube Coating Specifications
           42397        O-Ring #126
55545  Bracket
18105  1/4 x 1/2 Lg Hex Socket Cap Screw (2)
55544  Adaptor
55543  Bracket
55542  Adaptor
22438  3/8 x 1/2 Hex Cap Screw (2)
55594  #10 x 3/8 Lg Socket Hd Cap Screw (4)
15990  Grommet
55687  Conduit Clip (9)
18105  1/4 x 1/2 Lg Hex Hd Bolt (11)
11334  1/4 Stop Nut (11)
55688  Switch Box Assembly
           55689        Switch Box - Machined
                        54481  Switch Box
           27024        Terminal Board
           30824        Pop Rivet (2)
           17873        Solderless Terminal (4)
55690  Sealtite Connector (5)
55691  Grounding Ferrule
19926  Grommet
55692  Sealer
19922  1/2" Sealtite Conduit (22 ft. approximately)
19921  #4 Gage Electric Wire (25 ft. approximately)
19920  #16 Gage Electric Wire (25 ft. approximately)
19929  Terminal (5)
17873  Terminal (7)
19931  Terminal
55623  Rollpin
51656  Nozzle Support
36228  Paint Specifications
```